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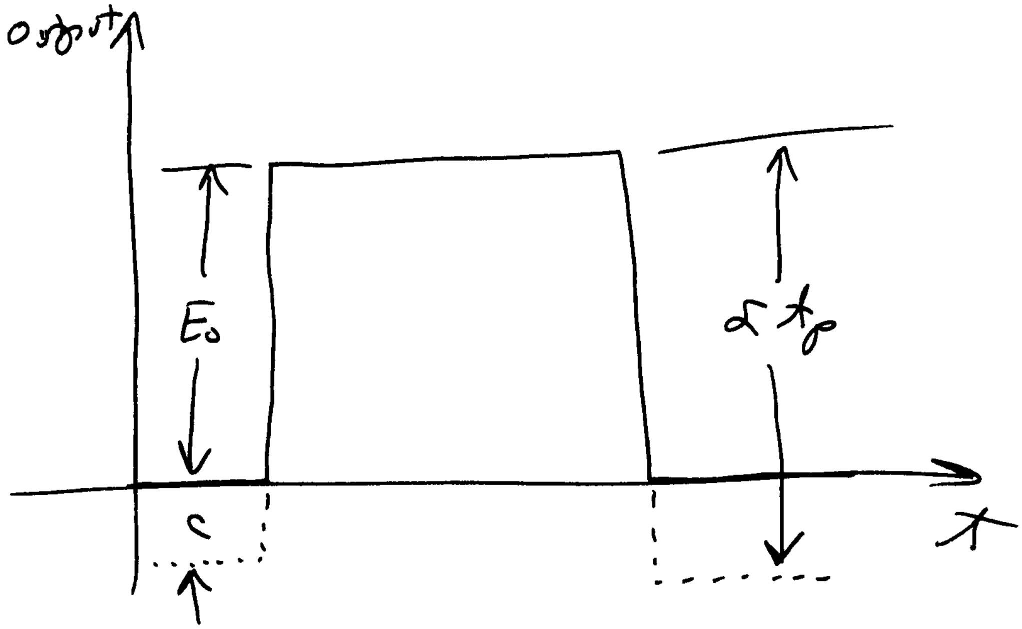
PULSE WIDTH TO PULSE HEIGHT CONVERTER

Specifications

The specifications of the unit, as determined from measurements and the demonstration of the overall system, are as follows:

Input pulse amplitude	0.5v to 20 volts, negative with respect to ground.
Input pulse width	approximately 10 millisecond to 100 millisecond, with 0.2 millisecond rise time.
Input pulse rate	essentially random but with a maximum rate of 8 per second. Converter can handle isolated pulses.
Output pulse width	approximately 20 millisecond, not critical.
Output pulse amplitude	maximum of 100 volts positive with respect to ground as base, nominal range of approximately 5 to 50 volts for the input pulse width range.
Input-Output transfer function .	Let E_o = amplitude above ground of output pulse
	t_p = input pulse width
then	$E_O = \alpha t_p + C \quad \left\{ \begin{array}{l} E_o \geq 0 \\ t_{min} \leq t_p \leq t_{max} \end{array} \right\}$

Converter has α and C adjustable so that the output pulse amplitude range will be approximately 5 to 50 volts over the input pulse width range.



Circuit Description

A. Block Diagram

The Pulse-Width to Pulse-Height Converter is shown in block diagram form (Figure I) and a brief description of the operation follows:

A small positive input signal is amplified and used to trigger a Schmidt circuit. While the Schmidt is triggered, a capacitor in the sawtooth generator is charged, linearly with voltage. This signal is sent through a storage circuit, consisting of a diode and capacitor, so that the cathode follower is maintained at the peak value of the sawtooth

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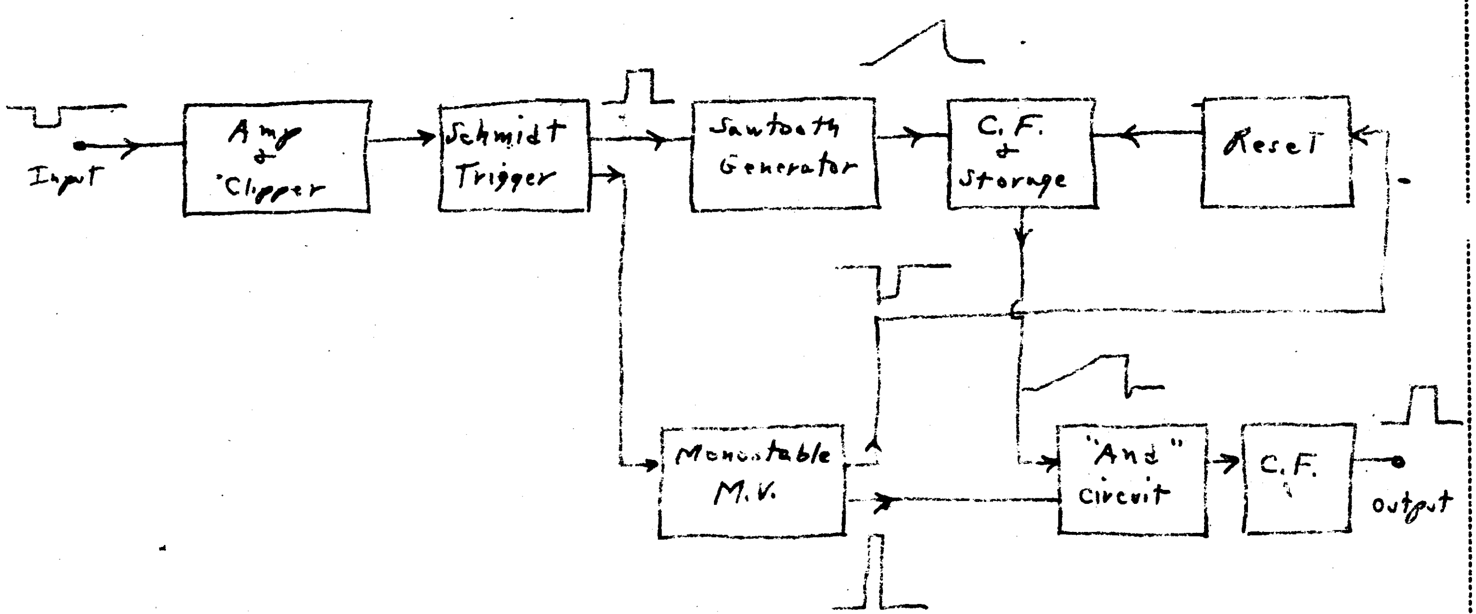

FIG I

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waveform. When the Schmidt returns to its normal state, it triggers the monostable multivibrator. The positive signal from the multivibrator is used to gate "on" the "AND" circuit and the trailing edge of the negative signal is used to reset the storage circuit.

B. Final Schematic

A schematic diagram of the pulse width-to-pulse height converter circuit is shown in Figure II.

The negative input signal is amplified at V1A and passed on to V1B. V1B is capacitively coupled to V2A in order to transfer the full signal without the problem of voltage levels as would be the case in direct coupling. The capacitor is rapidly recharged by the diode in order for the system to function when a train of pulses is applied. The positive pulses (see T.P. 1) from V2A are used to trigger the Schmidt circuit V3. The Schmidt circuit will trigger when the grid of the non-conducting tube reaches 39 volts. The hysteresis is less than 1 volt due to the choice of plate resistances. The value of the 82 K resistor may, in some models, have to be changed due to the voltage drop in the NE2's located on the place of V2A, since the drop in some NE2's may be different from others. The positive output (see T.P. 2) from the Schmidt circuit is used to cause V4A to conduct, thereby cutting off V4B by raising the common cathodes well above the grid of V4B.

Ordinarily, the grid of V2B is set at 100 v, so that approximately 100 volts is across the cathode resistors of V2B. Therefore, the cathode current passes through V4B, the plate of which is clamped above ground. When V4B is cut off, the current passes into the capacitor which is on the grid of V5A. The voltage on this capacitor will increase linearly if the current into the capacitor is constant. The current is held constant by maintaining a constant voltage across the V2B cathode resistors. This is achieved by coupling the output of V5A to V2B. The diode on the grid of V2B is used to allow the coupling capacitor to regain rapidly any charge that it may lose during operation. Since the signal on the cathode of V2B is almost as large as that on the grid of V5A, the voltage across the cathode resistor is almost constant. The variable resistor is used to change the slope of the voltage, in order to vary the gain of the system. This resistor determines the value of α in the expression for the output voltage pulse. At the end of the input pulse V4B begins to conduct and the capacitor on the grid of V5A is rapidly discharged to ground potential.

This triangular waveform (see T. P. 3) is passed through a diode and onto the grid of V6A. The storage capacitor which is connected directly to the grid of V6A charges when a waveform is applied, but remains at its peak value after the waveform has passed.

A positive gate signal (see T.P. 5) is needed to pass only the horizontal portion of the signal from V6A (see T.P. 4) to the output stage V5B. This is accomplished by the monostable multivibrator V8 which is triggered by the trailing edge of the input signal. V7B is used as the trigger tube. The trailing edge of the negative gate signal is used to discharge the storage capacitor. This is done by causing V7A to conduct heavily, thereby lowering the plate of the cathode follower V6A below ground. When this happens, the grid of V6A will conduct and discharge the storage capacitor. A potentiometer in the cathode of V6A determines the value of "C" in the expression for the output voltage pulse. Values of C between zero and -10 volts can be obtained with the circuit values shown.

Power supply schematic is shown in Figure III.

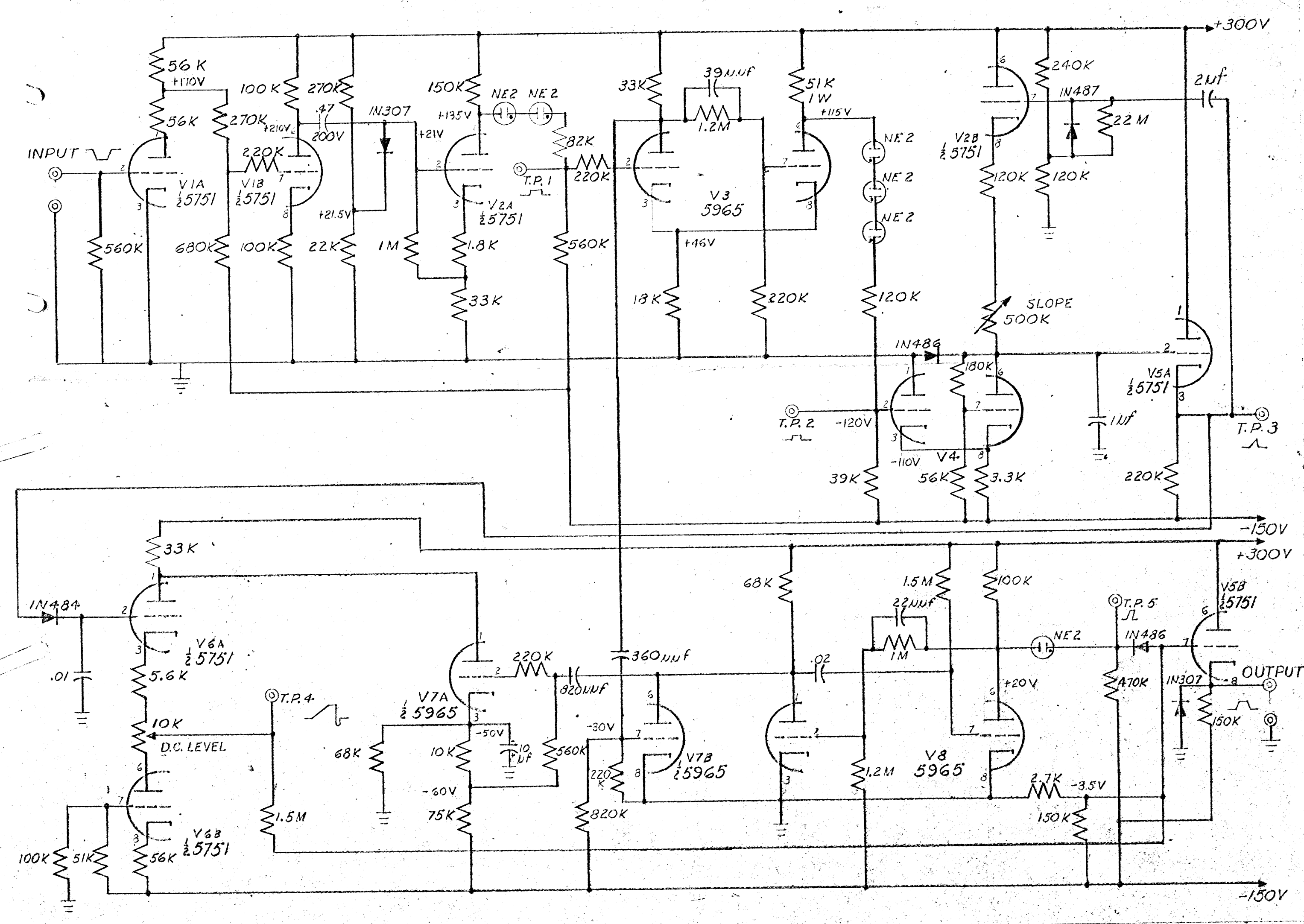

FIGURE I-3-2 PULSE WIDTH TO PULSE HEIGHT CONVERTER

Pulse Width to Pulse Height Converter — Power Supply

Rect. Diodes :- M500

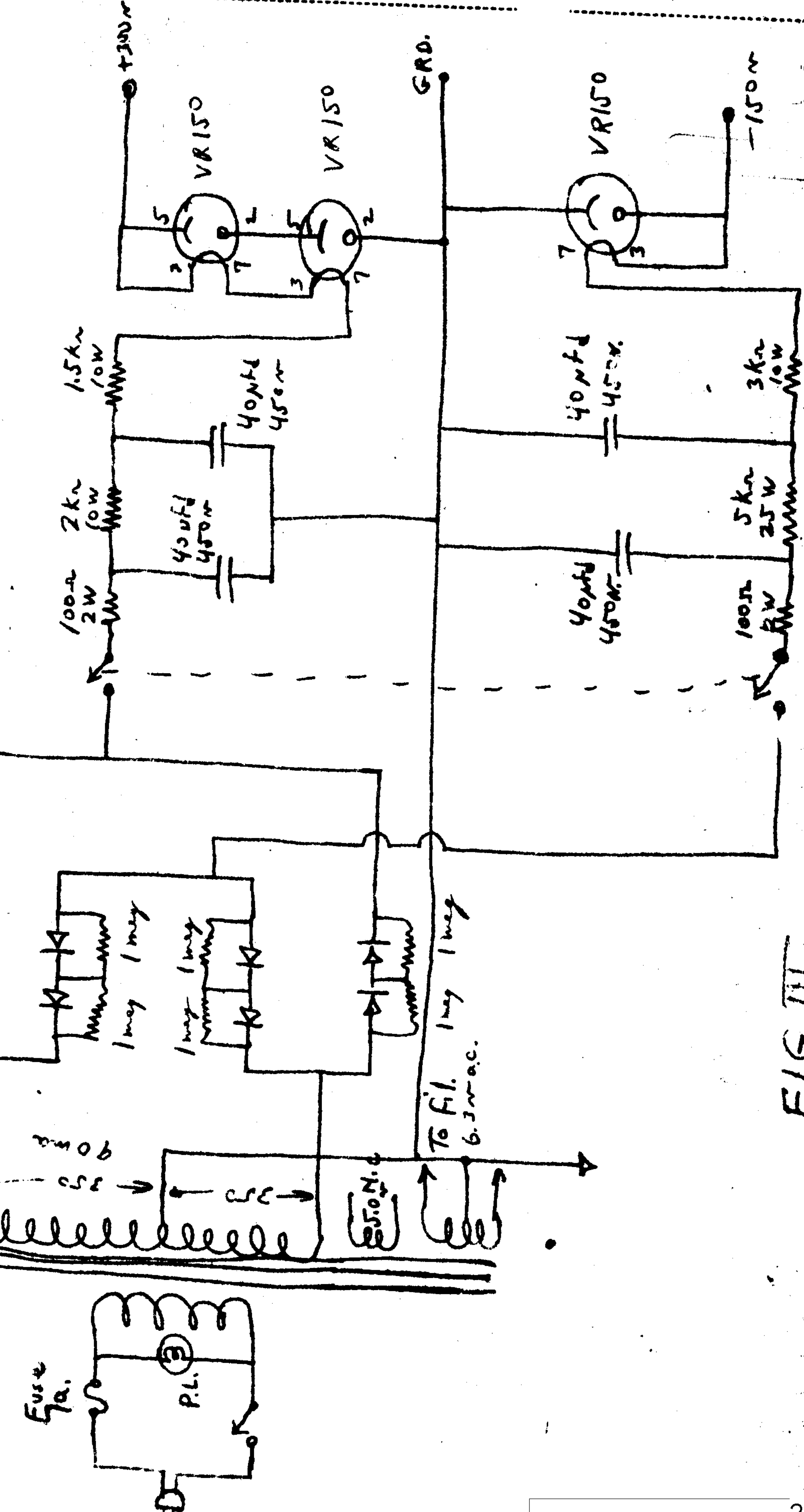

FIG. III

RECEIVER MODIFICATION

The Pulse-Converter requires pulses of negative amplitude with a zero voltage base line, so the following modifications were made to a Clarke Model 167-J-1 receiver. Output was taken from the grid circuit of V-106 (6 CB 6) at TP-110. For convenience, the video output coax connector was disconnected from V-110 (12AV7) and used as the pulse output connector. Since amplitude detection is required, the receiver is operated on the "AM" position of the AM - FM - Standby switch. To remove the effects of the A. G. C. in the I. F. stages, the A. G. C. line was held at a constant voltage by putting a battery (positive to ground) on TP-118. To suppress residual noise, -3 to -6 volts is required.

If any other type of receiver is used, the output pulse should be taken directly from the second detector (i. e. direct coupled circuitry) and the a g c or a v c suppressed. Usually, the time constant of the a g c circuit will distort the output pulse amplitude due to its large time constant.

SIMULATED TRANSDUCER

This is a piece of test gear used to check the Modulator-Transmitter. A 10 KΩ Helipot represents the transducer. The silicon transistor acts as a switch to connect the slider on the potentiometer to the output point, "C". A G. R. Unit Pulser, modified to give a repetition rate of 8 pps with a positive pulse width between 0.1 and 1 milliseconds, drives the silicon transistor into conduction. The duration of the pulse represents the dwell time of the transducer.

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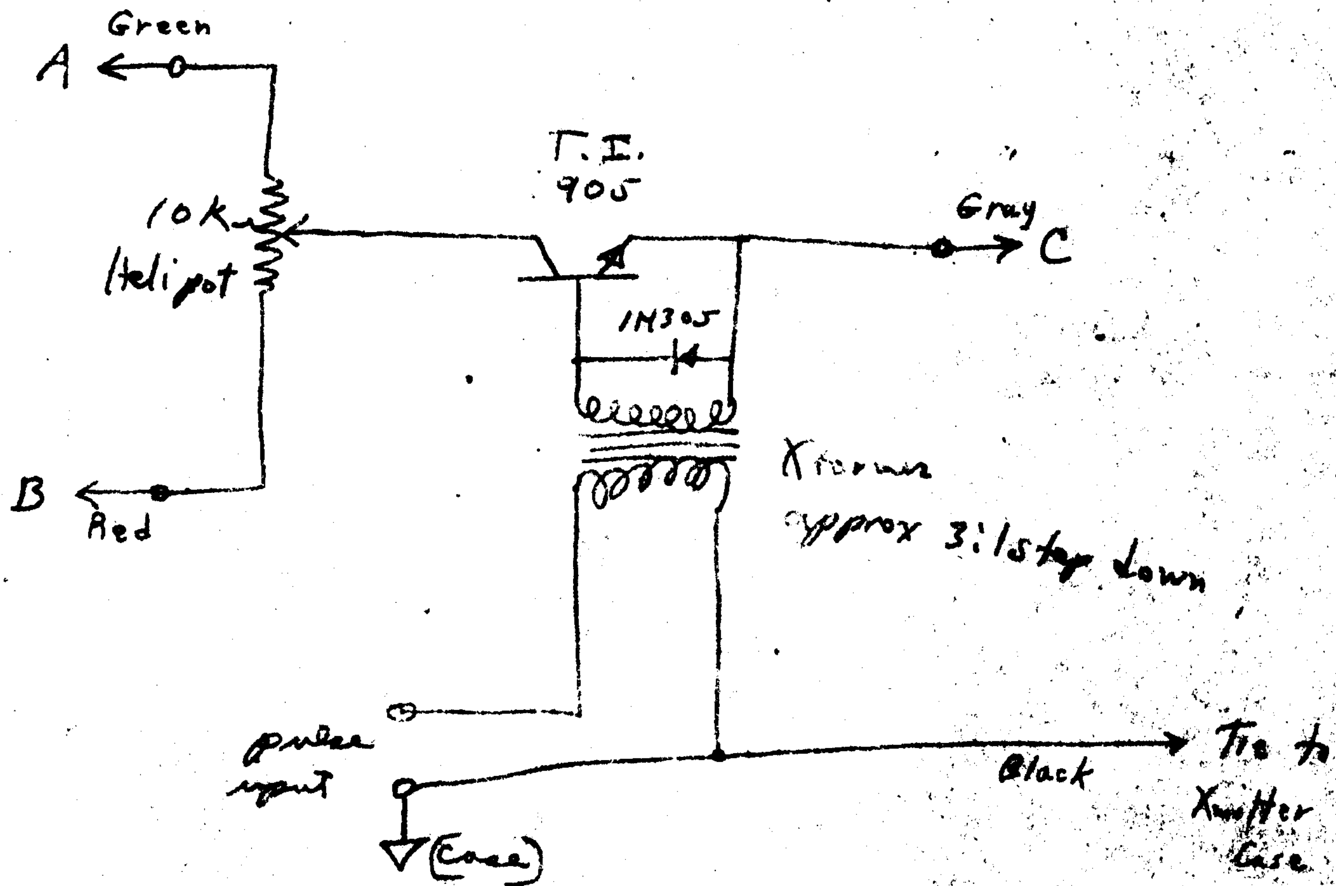
Simulated Transducer



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PRECISION PULSE HEIGHT MEASUREMENT

General

The purpose of this device is to measure the peak value of any waveform. Any pulse from 0 to 100 V may be applied to the input and the peak value of the pulse will be stored so that comparison can be made between the stored voltage and an accurate voltage across a helipot.

Circuit Description

The preliminary working model is shown in Figure I and the final working model is shown in Figure 3. The preliminary working model had two major difficulties which required a redesign to Figure 3. Figure 2 shows the power supply.

Briefly, the principal of operation is as follows (Fig. 1). The 0.1 mfd storage capacitor is charged up so that grid 2 of VIA is held at the input voltage peak. In order for the cathode follower VIA to have a voltage gain of exactly 1, the plate-cathode voltage and the plate current must both remain constant. The phase inverter V4A and the amplifier V4B did not keep points A and B equipotentially spaced at all voltage levels therefore resulting in a deviation of voltage gain of 1 for V1A. This was one of the major difficulties encountered. The other difficulty was the small grid current in V1A which caused the 0.1 mfd storage capacitor to charge its charge. It was found that for the prevailing conditions the grid current flowed into the capacitor so that the storage voltage climbed continuously.

Figure 3 shows the improved design. The purpose of the two pole input switch is to connect only two contacts from the switch onto the grid of the electrometer tube. If a one-pole switch were used, then the pole would have to be connected to the grid of V1. This connection might be more liable to introduce leakage. The electrometer tube V1 is used because of its extremely low grid current so that the 0.05 mfd storage capacitor on grid 1 of V1 will not gain or lose charge. It is very important to keep a constant plate-cathode current in V1 in order to maintain a constant grid-cathode voltage over a wide range of input voltage (0 - 100 volts). By stacking two high gain tubes (V7 and V6A), it is possible to maintain the current within extremely small limits.

Points A and B remain equipotentially space at about 100 volts which cause the plate-cathode voltage of V1 and V2A to remain constant as the input voltage is varied. The cathode current of V2A is likewise held constant by V5A and V5B. Since both V1 and V2A have a voltage gain of exactly one, point A will always remain at a small constant potential difference higher than the input voltage. The VXR-130 is used merely to insure a constant voltage of 100 V across the 50 K helipot in case of a slight current change.

V2B, V3, and V6B are used to maintain points A and B equipotentially spaced. The signal from V2A is fed to cathode follower V3A. This in turn drives the cathode of V3B. The grid of V3B is held at a constant voltage (about 100 V) from point B by the constant voltage across the 100K resistor at the junction of grid 7 of V3B and plate 6 of V6B. V6B is used to generate the constant current. Plate 6 of V3B holds grid 7 of V2B at the proper potential to maintain points A and B at a constant voltage difference due to the constant voltage drop from cathode 8 of V2B to grid 7 of V3B. If point B tries to rise too high above point A, grid 7 of V3B will also rise thereby lowering the plate of V3B and grid of V2B. The opposite happens if Point B tries to go below the voltage difference with respect to point A. The gain of the system is high enough so that this corrective action maintains points A and B at a voltage difference that remains within very close limits.

V4 is used as a differential amplifier. When grid 6 is at zero potential, then a null will be indicated by the galvanometer. Since only 0.15 volts is needed for full deflection of the galvanometer, the diodes are used as shown in the diagram. Electrically the diodes are out of the circuit until the voltage across them reaches almost 0.4 volts at which point they start to conduct. This voltage is enough to partially reflect the galvanometer since it has a 6.8 K resistor in series with it. At no point will these diodes allow a high enough voltage to appear across the meter to damage it.

Operation

There are three screwdriver adjustments which once set may need only occasional readjustment. The 25 K potentiometer in series with the helipot must be set so that there is 100 volts across the helipot. The 100 K potentiometer in the cathode circuit of V6A should be set so that the plate-cathode voltage on V1 is about 10 volts. Of course, all adjustments should be made only after the unit has warmed up thoroughly. The 1 K potentiometer on the "Reset" position of the 3 position switch should be adjusted to compensate for the error introduced by the input diode. This control can be readily adjusted by applying a small voltage to the input. A small voltage should be used because it can be measured within less than a tenth of a volt with a voltmeter. Set the 1 K potentiometer so that the "Reset" position of the switch is at about -0.1 volt. With the input switch on the "Reset" position and the helipot on zero, set the galvanometer to zero with the Zero Null Adjustment. Put the input switch to the "Input" position and set the helipot for a null in the galvanometer. If the helipot dial reads too low, increase the negative voltage on the "Reset" position of the input switch by the difference between the input voltage and the indicated voltage on the helipot dial.

The operation of the instrument is fairly simple. The A-C switch should be turned on to allow all filaments to warm up before B + is applied. The electrometer tube filament is controlled by this switch. The input switch should be on the "Reset" position and with the helipot dial set on zero, a null on the galvanometer is obtained by the Zero Null Adjustment. The input switch is then set at the "Input" position. As soon as the storage capacitor is charged to the peak value of the pulse or any other voltage being measured, the switch must be switched to the "Open" position to prevent any charge from being leaked off. The helipot can now be adjusted for a null indication and the voltage to be measured can be read from the helipot dial.

To turn the instrument off, turn off the B + switch first and then after about three minutes turn off the A-C switch. The reason for this delay in turning off the A-C switch is to keep the filament of V1 heated so that the discharging electrolytic capacitors can not put a dangerously high voltage across the tube since the normal plate voltage of this tube is only about 10 volts.

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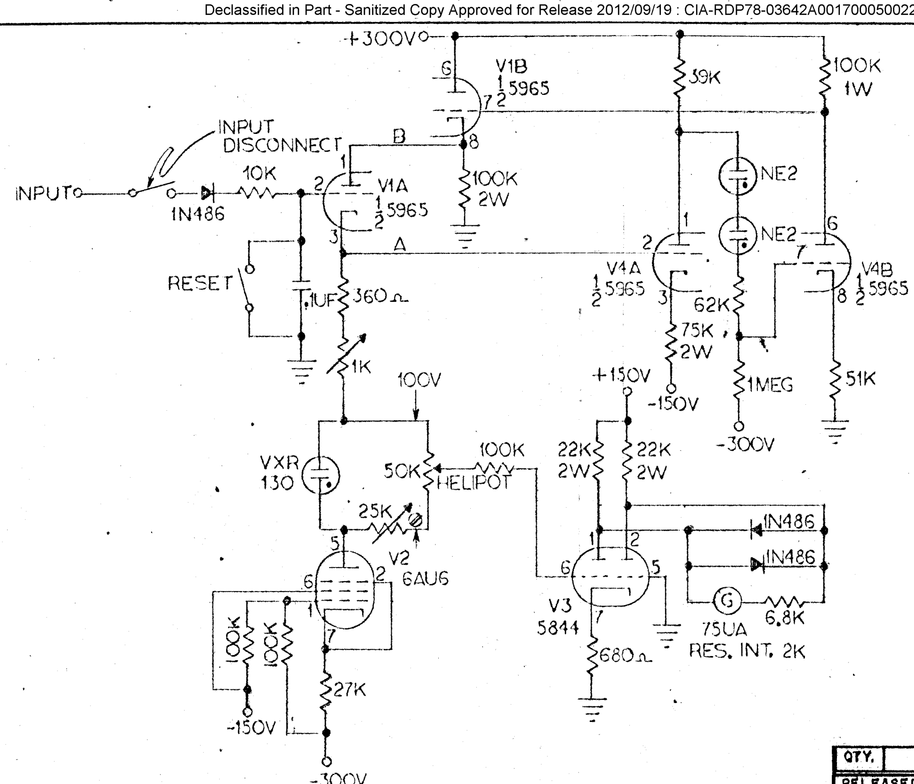

FIGURE 1

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REVISIONS

QTY.		DESCRIPTION	STOCK NO.	PT.#

RELEASED: PROCUREMENT
RELEASED: PROTOTYPE
RELEASED: PILOT RUN
RELEASED: FULL PRODUCTION

TOLERANCES UNLESS NOTED ARE FRACTIONAL ± 1/64 DECIMAL ± .010

UNLESS NOTED ALL RESISTORS ARE 1/2WATT AND ± 5%

DR | CK. | APP.

SCHEMATIC - PRECISION PULSE HEIGHT MEASUREMENT

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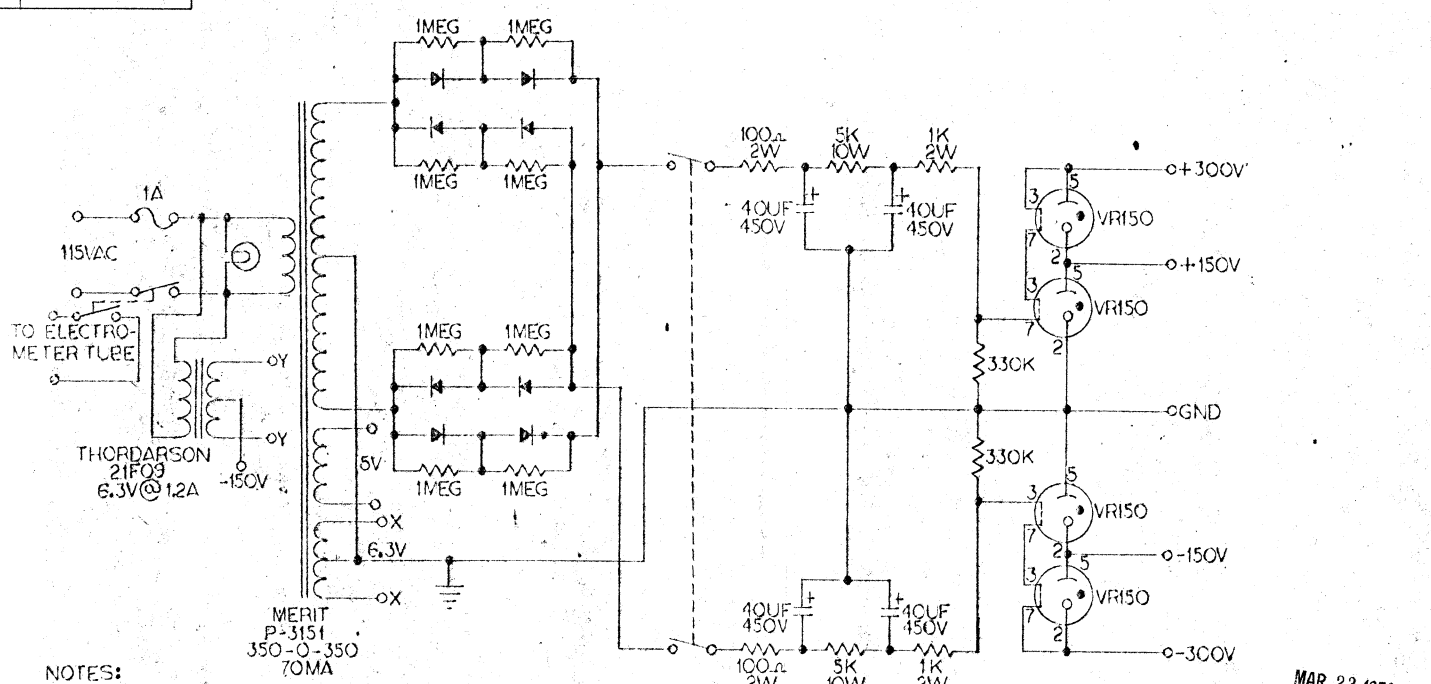
DIMENSIONS IN INCHES
DO NOT SCALE PRINT



NOTES:
1. ALL DIODES = M500
2. V2, V3, V4, V5 } FIL. TO X-X
V5, V6, V7 } FIL. TO Y-Y

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FIGURE 2

G3	G2	G1	DRAWING NO.	STORES NO.	ITEM	DESCRIPTION
QUAN./GROUP						

SCALE	MATERIAL	SCHEMATIC-POWER SUPPLY PRECISION PULSE HEIGHT
	FINISH	FIRST MADE FOR
DRAWN	DATE 3-?-?8	J.O. 5080 QTY.
CHECKED		B5080-101
APP'D.		REV. 0

REVISIONS

USED ON

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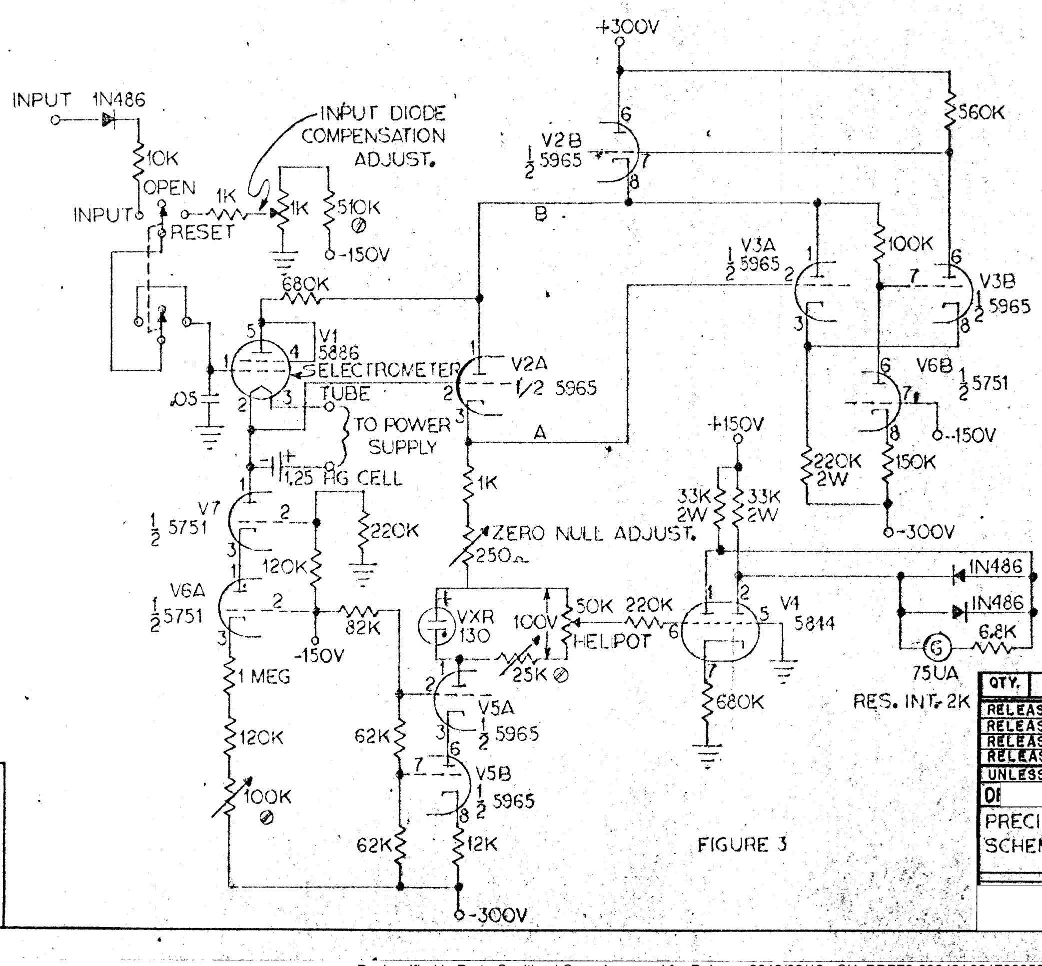

FIGURE 3

QTY.	DESCRIPTION	STOCK NO.	PT.#
RELEASED: PROCUREMENT		TOLERANCES UNLESS NOTED ARE FRACTIONAL ± 1/64 DECIMAL ± .010	
RELEASED: PROTOTYPE			
RELEASED: PILOT RUN			
RELEASED: FULL PRODUCTION			
UNLESS NOTED ALL RESISTORS ARE 1/2 WATT AND ± 5%			
DR	CK.	APP.	

PRECISION PULSE HEIGHT MEASURING DEVICE SCHEMATIC

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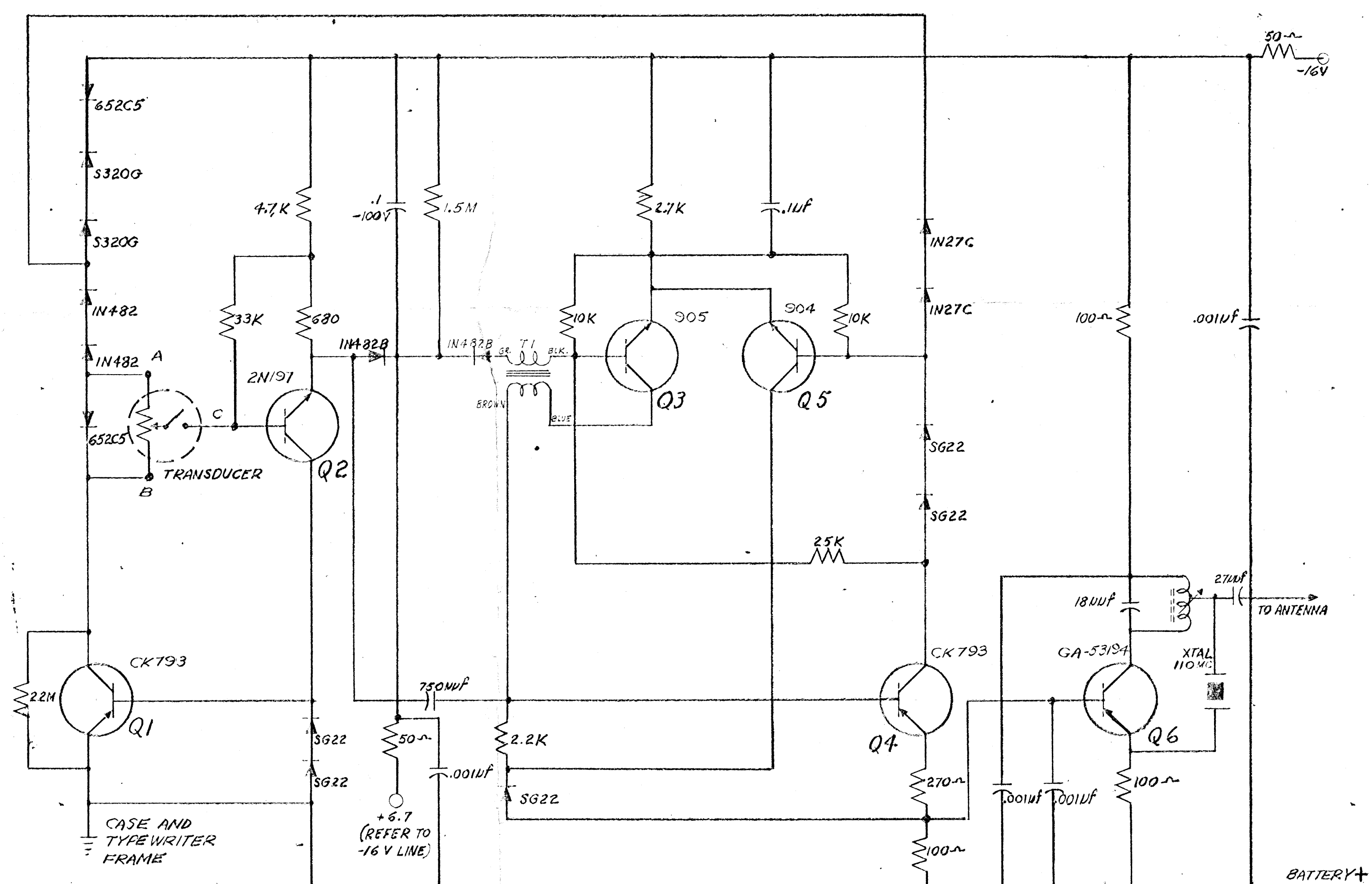

FIGURE PULSE WIDTH MODULATOR AND TRANSMITTER

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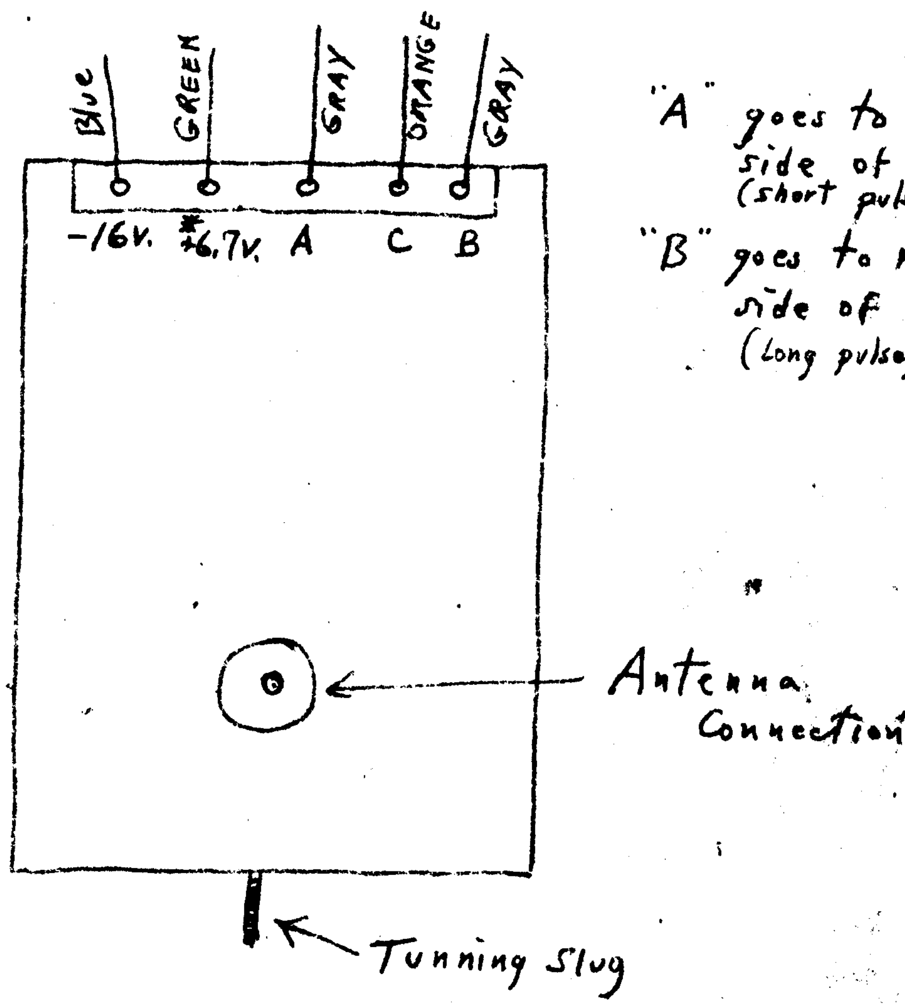
Modulator - Transmitter

Top View

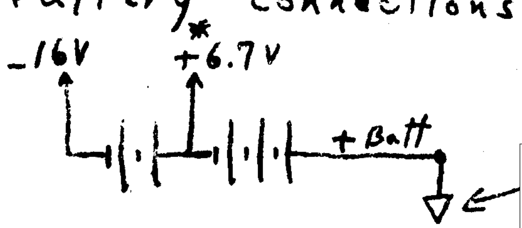
(Looking at unit with bell cover removed)



"A" goes to left side of board (short pulse)

"B" goes to right side of board (Long pulse)

Battery connections



Frame

* Voltage refered to -16 v terminal

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